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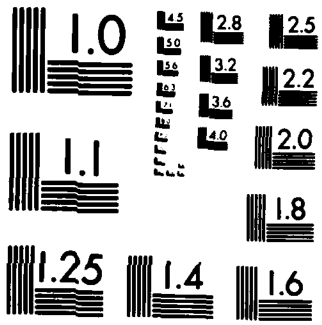

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FOREIGN TECHNOLOGY DIVISION

EROSION OF ELECTRODES DUE TO SWITCHING OF CAPACITOR-BANK DISCHARGE CIRCUITS

by

G.M. Goncharenko, Ye.N. Prokhorov

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*<u>ye</u> initially, after vowels, and after ъ, ь; <u>e</u> elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

GRAPHICS DISCLAIMER

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EROSION OF ELECTRODES DUE TO SWITCHING OF CAPACITOR-BANK DISCHARGE CIRCUITS

Doc. G. M. Goncharenko, Ye. N. Prokhorov, sen. engineer

The erosion of the contact surfaces of the electrodes in switches affects not only the service life of the electrodes and their insulation but also the basic characteristics of the switches - there is a variation in static breakdown voltages, operation lag time, and variation in the operation time. One of the main quantitative characteristics of erosion is the mass of metal ejected from the surface of the electrode [1, 2, 3].

This work is devoted to an experimental determination of the mass of metal ejected from the surface of electrodes made from different materials by weighing on a VT-1 balance and visual observation of the surfaces being eroded. The geometry of the electrodes and the size of the gap between them (Fig. 1) modeled the construction of the electrodes and the conditions of the displacement of craters under the effect of electromotive forces in the switches

of the discharge circuits of large capacitor banks.

The battery consisted of 22 IM-50/3 capacitors. The currents and the amount of electricity passing in the period of one discharge (in the time it takes the current to drop to 0 from its initial amplitude) were controlled by varying the initial voltage on the capacitors and the inductance of the discharge circuit. However, with the oscillation period being constant, the electric discharge passing through the discharge circuit changed simultaneously with the change in current amplitude, which somewhat limits the possibility of comparing the obtained results.

The experiments were conducted with $I_M = (0.12-1.2)°10^6$ A, T=90 and 13 μs, $\beta = \frac{2}{2L}$ and 25)$°10^3$ I/s. The shape and the geometrical dimensions of the electrodes are shown in Fig. 1b. Copper electrodes also had dimensions as shown in Fig. 1c.

It was determined experimentally that the loss of mass from copper electrodes in Figs. 1b and 1c is virtually identical. Fig. 2 shows the graphs of the amount of metal ejected from the electrodes versus the amount of flowing electricity. Due to the attenuation smallness of the current the wearing of both electrodes in the pairs studied was independent of their initial polarity. The unevennesses on the surface of copper electrodes due to erosion prove to be

smaller independently of whether both electrodes are copper or just one of them. It is also necessary to note that at certain currents (see Table 1), the amount of metal ejected depends not only on the flowing charge but also on the current. The effect of the current's rate of change during the constancy of its amplitude and magnitude of the flowing charge is yet to be investigated.

It was established that the first discharge left a trail on the polished surfaces of any one of the materials used along the entire length of the electrode (100 mm) at currents ≥500 kA. As the roughness of the surface increased the length of the path of the movement of craters decreased during subsequent discharges and the outline of the trail became ellipse-shaped, elongated in the direction of emf action. In these instances, the area of the trail takes up only part of the surface of the electrodes along their lenght. Further, beyond the boundary of the trail, we observed precipitation of the transferred metal and the appearance of isolated projections measuring 1 mm in height. When the electrodes were weighed, naturally, the mass of the transferred metal could not be taken into account. Thus, the metal mass ejected directly from the activity zone of the discharge channel exceeds those given in Fig. 2. If the erosion surfaces of the electrodes are subjected to the effect of subsequent discharges with current $I_M = 120$ kA, T=90 μs, the unevennesses disappear and the surface becomes shiny.

To illustrate mechanical loads, we note that with thin-walled copper electrodes (δ=2 mm), having the profile depicted in Fig. 1c, there was pressing through of the electrodes to a depth of 3 mm at currents $I_M \approx 10^4$ A.

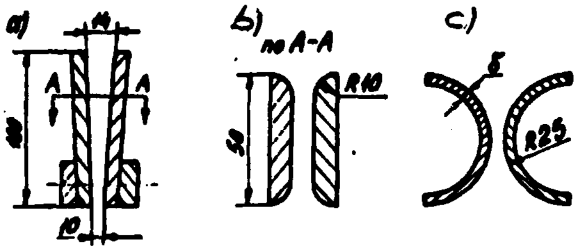

Fig. 1. Electrode structure.

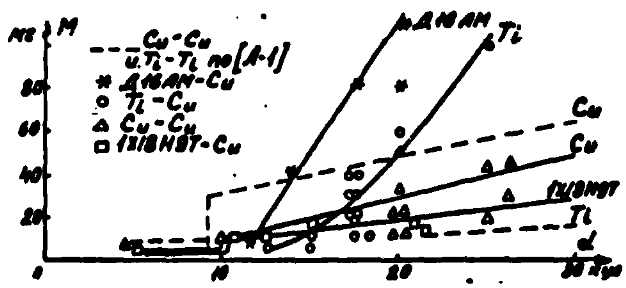

Fig. 2. Metal mass ejected from the electrodes as a function of the charge that passed with T=13 μs. Key: мг=mg кул=coulomb

Table 1. Wear of Electrodes. Pair: Cu-1X18H9T.

		$I_м$=550ка, T=13мксек		$I_м$=120ка, T=90мксек
(a)	Материал	10 кул	15 кул	18 кул
(b)	медь	10	10	2
(c)	Ст. нерж.	10	10	2

Key: (a) Material; (b) Copper; (c) Stainless steel; ка=кА; мксек=μs;

кул=coulomb

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